SUSTAINABLE
AUTOMATION

Steve Drouilhet, President
Sustainable Automation LLC
4560 Osage Drive
Boulder, CO 80303
USA
Phone: 1-303-543-6057
www.SustainableAutomation.com

System Integration and Advanced Controls for Wind Hybrid Village Power and Distributed Generation

Introduction

Over the past 25 years, wind power has grown to be a multi-billion dollar industry, with large-scale wind farms deployed in many countries worldwide. Similarly, hundreds of thousands of small-scale wind turbines and PV solar systems have been implemented worldwide, mostly in remote residential applications. Yet wind energy has barely begun to realize its market potential is in the areas of community and industrial scale distributed generation. Several factors combine to work against the implementation of renewable energy in distributed generation applications. These are the relatively high capital cost of most renewable energy equipment, the high cost of system integration, the intermittent and non-dispatchable nature of most renewable energies, and prevailing electric rate structures. Most large electric customers are subject to both an energy charge and a demand charge. An industrial or institutional customer who installs one or several wind turbines to reduce his energy purchases from the utility typically only reduces his energy charge. Because wind energy is intermittent, there is no assurance that will be available at all when the customer experiences his peak load, and thus the customer will usually be billed the full demand charge, which can easily represent 50% of his original electric bill. Under these conditions, wind energy often appears economically unattractive, considering the relatively high initial cost. Hybridizing wind (and potentially other intermittent renewables) with other distributed generation technologies, such as microturbines and reciprocating engine generators, is an approach that can unlock the potential of renewable energy to be widely implemented in commercial and industrial distributed generation applications. Because the fuel-powered generation is inherently dispatchable, it can be used to firm up the renewable generation capacity and ensure that any desired portion of the local demand can be met at all times by the distributed generation. If a renewable fuel, such as biodiesel, powers the backup generation, then the system represents the ultimate in environmental sustainability, offering firm electric power and thermal energy using purely renewable energy.

Our Company Origins

Sustainable Automation is a relatively new company dedicated to the premise that renewable energy, wind energy in particular, has the potential to play a large role in the growing movement toward distributed generation. The company was founded in 2002 by Steve Drouilhet, whose experience in the wind industry spans more than 20 years, having begun his career in 1982 as a field test engineer on the very first California wind farm, in Altamont Pass. From 1994 to 2002, he worked at the National Wind Technology Center (NWTC) at the National Renewable Energy Laboratory (NREL), where he led NREL's program in wind-diesel hybrid system research and development. He was the principal designer of the high penetration wind-diesel power system implemented in the arctic village of Wales, Alaska.

Our Approach

The economic viability of a distributed generation project is determined both by first cost of the system and by its long term O&M requirements. Sustainable Automation is striving to reduce the first cost of hybrid systems by streamlining site assessment and system design procedures and by creating a product line of power system building blocks from which a given system can be rapidly configured and implemented. We are applying this modularization concept both to the various power system components used (e.g. wind turbines, diesel generator sets, secondary loads, power converters, energy storage devices, etc.) and to the control hardware and software that makes the power components work smoothly together. We strive to minimize long-term support and operating costs by creating very intuitive operator interfaces and by building all of our controls equipment to a high standard of reliability and serviceability.

Applications That We Address

Village Power

In many regions of the world, standalone diesel power systems are the principal means of rural electrification. Diesel generators have high operating costs in remote areas due to high routine maintenance requirements and high cost of fuel transport and storage. In regions where the wind resource is good, wind-diesel hybrid power is increasingly being recognized as the technology of choice for reducing the overall cost and environmental impact of electric power generation in remote communities. Sustainable Automation provides system integration engineering expertise to rural utilities and village power project developers interested in implementing such systems. Once the power system is fully defined, Sustainable Automation can supply the core control components that will allow the system to function optimally and in fully automatic mode.

Four Atlantic Orient Corp. 65 kW wind turbines installed in the arctic village of Selawik, Alaska.

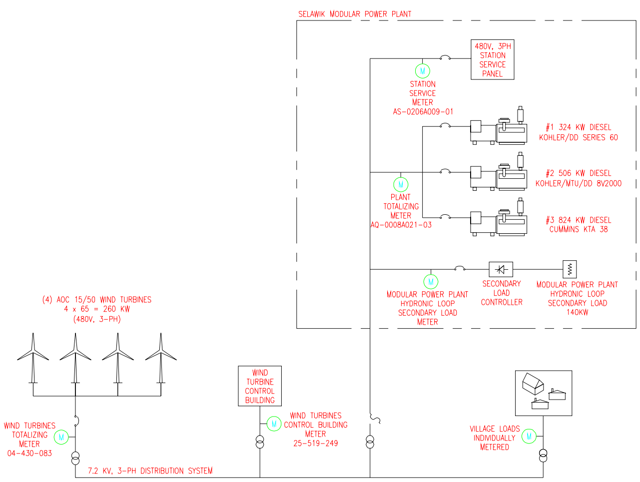


Diagram of the wind-diesel village power system in Selawik, Alaska.

Industrial Distributed Generation

Combining wind turbines or other renewable energy sources with various types of conventional distributed generation equipment (diesel generator sets, natural gas powered reciprocating engine generator sets, microturbines, etc.) can greatly expand opportunities for renewable energy to participate in the industrial and commercial distributed generation market. The operation of the renewable and non-renewable generation sources can be automatically coordinated to minimize the user's energy costs given his particular electric and thermal load profile, utility rate structure, and financial incentives such as green energy tags.

A Fuhrlaender FL-250 wind turbine installed by Lorax Energy Systems at the Harbec Plastics factory in Ontario, NY. The wind turbine is part of a wind hybrid system incorporating gas microturbines, and heat recovery for space heating and cooling (using a an absorption chiller).

Services We Provide

Wind Resource Assessment

Most projects will require some level of wind resource assessment as part of the project feasibility study. Sustainable Automation conducts wind resource assessments as one component of its project planning services. Typically one year or more of data is required to accurately predict the performance of a given project, but often there exist publicly available data from nearby wind monitoring stations, which can be correlated with on-site data to enable long-term predictions from a relatively short period of on-site data collection. Sustainable Automation's wind resource assessment services include the following:

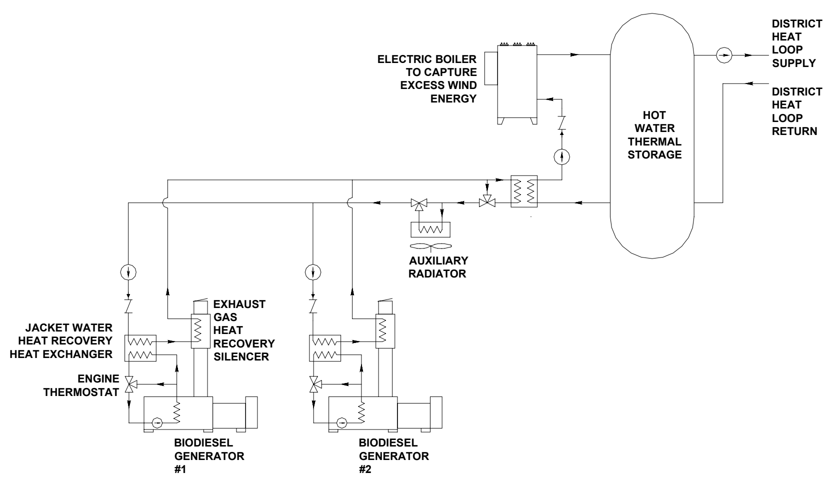
Sustainable Automation installed this 50m met tower as part of a wind resource assessment we are conducting for a planned wind-biodiesel hybrid project in Minnesota.

Facility Load Profiling

By evaluating all available data (gas and electric bills, equipment power ratings, plant operating characteristics, etc.) Sustainable Automation can develop approximate hourly, weekly, and monthly electric and thermal load profiles for a facility. These are necessary for both the design of a distributed generation system and accurate modeling of its performance. In cases of a highly variable load and/or where insufficient information exists, we have the equipment to measure and record minute-by-minute electric load of village power plants or industrial facilities.

Distributed Generation Project Performance and Economic Modeling

Using computer simulation tools developed at the National Renewable Energy Laboratory and elsewhere, we model the energy flows and economic performance of a proposed distributed generation system in light of the available renewable energy resources and the measured or estimated loads. The first phase of such a modeling effort focuses on determining an optimal system architecture and operating strategy. A second more detailed modeling phase aims to quantify various measures of performance of the system (e.g. wind energy produced, diesel fuel consumed, diesel generator run time, generator start/stops, wind energy dumped, etc.), which are then used to estimate the savings from reduced fuel consumption and/or reduced utility energy purchases. Whether for grid-connected industrial and commercial sites, or for off-grid village and remote industrial sites, we design the optimal hybrid power system to meet the customer's cost, fuel savings, and environmental goals. Where possible, excess wind energy and waste heat is captured to serve a variety of secondary loads, which may include water heating and chilling, water purification, and ice making.



Conceptual design of a biodiesel combined heat and power plant, part of a 2 MW wind-diesel hybrid power system planned for a Minnesota research center.

System Integration Engineering

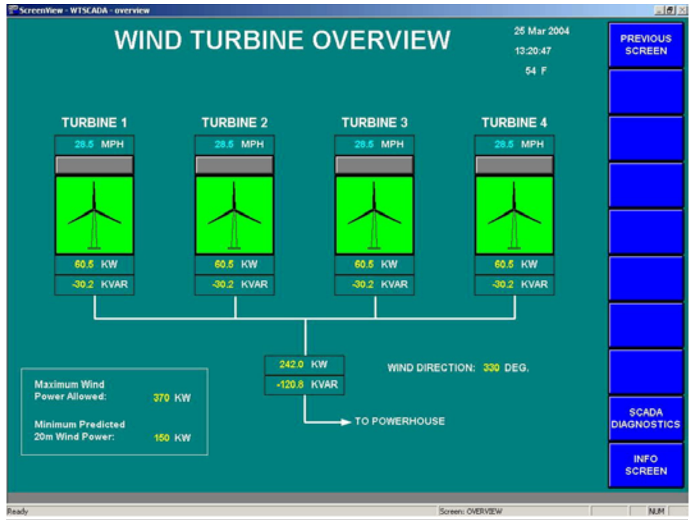
Successful implementation of wind hybrid power and/or distributed generation demands a systems approach, even where system components are supplied by multiple vendors. Once a system has been designed conceptually and analysis shows significant benefits, we integrate our control systems with various third party components, preparing detailed specifications and Request for Bids for the latter. For many equipment suppliers, hybrid power systems are an unknown application for their products, and it takes experienced hybrid system engineers to ensure that the power system components are specified correctly.

Products We Design and Manufacture

Hybrid Power System Supervisory Controllers

The Sustainable Automation Power System Supervisory Controller is a control panel typically located in the plant control room that serves as the top-level controller and the primary operator interface for the entire system. For example, a wind-diesel hybrid power system supervisory controller performs the following tasks:

- Diesel dispatch
- Wind turbine dispatch
- Secondary load dispatch
- Diesel status monitoring
- Wind turbine status monitoring
- Performance data logging
- Fault detection and annunciation
- Provide for remote access via dialup or internet



The Wind Turbine Overview screen on the Wind-Diesel SCADA system Sustainable Automation supplied to Selawik, Alaska.

The heart of the supervisory controller is an industrial-type panel mount PC computer with color touch screen monitor. Sustainable Automation prefers this platform for top level supervisory control, because it offers ease of implementing complex dispatch algorithms and creating powerful operator interfaces, and because it offers a variety of options for remote connectivity. The operator interface provides great flexibility to change the operating strategy through a variety of user-settable parameters.

Secondary Load Controllers

The Sustainable Automation Model SLC-HW Secondary Load Controller is a highly engineered fast-response power controller designed for use with electric hot water boilers. It is specifically designed for wind-diesel power systems where there is a need for diesel load control and/or system frequency control. The system is an evolution of the highly successful secondary load controllers used in the Wales High Penetration Wind-Diesel Project implemented by the U.S. Department of Energy's National Renewable Energy Laboratory.

Element switching is accomplished using thyristor solid-state relays (SSR) of the zero-switching type. Thus, all SSR switching is done at zero voltage, which eliminates the current waveform distortion and the poor power factor associated with phase-controlled SCR power controllers. All of the thyristors are directly bonded to integral heat sinks conservatively rated to handle their respective electrical loading. By switching on various combinations of the heating elements, any power level from zero to full load may be achieved, with a resolution of 1% to 4% of full load, depending on the model. Element switching is updated up to 50 times/second, allowing for smooth continuous control of electric power.

Back panel of a 140 kW secondary load controller built for the Alaska Village Electric Cooperative.